Fisheries and Oceans Canada | Pêches et Océans Canada
Ecosystems and Oceans Science | Sciences des écosystèmes et des océans
Central and Arctic Region
Canadian Science Advisory Secretariat
Science Response 2016/006

UPDATE OF STOCK STATUS INDICATORS FOR NORTHERN SHRIMP, *Pandalus borealis,* AND STRIPED SHRIMP, *Pandalus montagui,* IN THE WESTERN AND EASTERN ASSESSMENT ZONES FOR 2016

Context

Fisheries and Oceans Canada (DFO) Resource Management requested an update of Science advice on the stock status of the two species of shrimp, Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*P. montagui*), in the Western Assessment Zone (WAZ) and Eastern Assessment Zone (EAZ). The Zonal Advisory Process (ZAP) for the WAZ, EAZ and Shrimp Fishing Areas (SFA) 4-6 is scheduled for a full assessment of each SFA biennially (odd numbered years) with updates of the key indices of the Precautionary Approach (PA) framework in intervening years. The EAZ has been fully assessed three times as an assessment zone (DFO 2011, 2013, 2015) and twice prior as SFA 2 (DFO 2008, 2010). The WAZ has only been fully assessed as a unit once (DFO 2015). It had been assessed prior to that in 2010 (DFO 2010) and 2008 (DFO 2008) as SFA 2, 3 and 4 for *P. montagui* only. The status of resources in both the WAZ and EAZ have been updated between ZAPs in 2012 (DFO 2012) and 2014 (DFO 2014). Assessments follow the framework developed in 2007 for Northern Shrimp off Labrador and the northeastern coast of Newfoundland (DFO 2007a). The basis of the update is a series of previously reported fishery-independent surveys and fishery data, and new survey and catch data from the 2015/16 fishing season.

This Science Response Report results from the Science Response Process of January 2016 on the Update of Stock Status Indicators for Northern Shrimp, *Pandalus borealis*, and Striped Shrimp, *Pandalus montagui*, in the Western and Eastern Assessment Zones.

Background

The EAZ and WAZ (Fig. 1) were adopted as the basis for assessing the status of shrimp in SFA 2 and 3 at the 2011 ZAP (DFO 2011). The combined outline of the EAZ and WAZ is equivalent to the combined areas of SFAs 2 and 3 (subsequently redefined as SFAs Davis Strait, Nunavut and Nunavik) and their corresponding Management Units (Fig. 1) implemented in the 2013/14 fishing season.

Two exploitation rates are presented for each assessment zone and species because the total allowable catch (TAC) is not generally taken. Exploitation rate refers to the realized exploitation rate based on reported catch while the potential rate assumes the TAC had been caught.

In the EAZ, the first two years of survey data (2006–2007) are not considered comparable with the rest of the series because of poor trawl performance and incomplete sampling coverage in the Resolution Island survey area. These years are not considered when assessing trends in the indices from the EAZ.

In 2014, the Central and Arctic Region reorganized the surveys conducted within the region. For shrimp, this meant DFO would stop conducting the WAZ survey; the area is now surveyed during the Northern Shrimp Research Foundation–DFO survey so that the WAZ, EAZ and NAFO 2G survey areas are all sampled with the same ship, gear and at the same time of year. While this restarts the time series in the WAZ, the future benefits to the assessment of shrimp outweighs this shortcoming. It should be noted that while all historical data are presented in this report the two surveys are not directly

comparable as the surveys for the two zones were conducted with different ships, gear and at a different time of the year.

Resource status was evaluated within a Precautionary Approach (PA) framework (DFO 2006). Reference points (RP) were based on the geometric mean of female spawning stock biomass (SSB). The Limit Reference Point (LRP) is 30% of the mean and the Upper Stock Reference (USR) is 80% of the mean. RPs for SFA 2 were developed based on estimates from available surveys (2006-2008) at that time (DFO 2009) and implemented in the Integrated Fisheries Management Plan (IFMP; DFO 2007b). These RPs were transferred unchanged to the EAZ. RPs for the WAZ were developed in 2013 (DFO 2013). However, the restart of the time series means these RPs are no longer valid and as a consequence no PA framework is currently available for the WAZ.

Analysis and Response

Update of Indicators

Eastern Assessment Zone – *P. borealis*

Fishery

The total catch (directed and by-catch) of *P. borealis* in the EAZ, as of 18 November 2015, was 4,468 t, 54% of the TAC (Table 1, Fig. 2). The 2015/16 fishery runs until 31 March 2016, and with vessels still fishing the area, catch records are incomplete for 2015/16. The majority of catch taken in the EAZ comes from SFA DS-W (Fig. 1) southeast of Resolution Island and east of the Nunavut and Nunavik Land Claims borders.

Biomass

The fishable biomass index increased by 56% from 2014 to 2015 and is now at the high previously seen in the time series (Table 2, Fig. 3a). The SSB index showed an even larger increase of 79%. The female SSB index is the highest in the time series, over 13,000 t higher than the previous maximum in 2011 (Table 2, Fig. 3b).

Exploitation

The reported exploitation rate (ER) index for 2015/16, as of 18 November 2015, was 5.7% (Fig. 4a). Since the fishery was still actively being fished, the reported ER will be higher at the end of the season. Should the entire TAC be taken this fishing season, the potential ER index for 2015/16 would be 10.4% (Fig. 4b) with less than a 1% chance of being above 20%. The long term average of the potential ER is 14.3% near the 15% harvest rate goal for the EAZ.

Current Outlook

The female SSB index for *P. borealis* in the EAZ is currently well within the Healthy Zone of the PA Framework (Fig. 5).

Eastern Assessment Zone – *P. montagui*

Fishery

The catch of *P. montagui* in the EAZ declined steadily from about 4,000 t in 2000 to about 135 t by 2011/12 (Table 1, Fig. 6). Increased fishing effort around Resolution Island within the land claims areas in 2012/13 increased the catch to 1,173 t. As of 18 November 2015, the 2015/16 catch was only about 25 t. With vessels still fishing the area at the time this report was written, the final catch will be higher.

Biomass

The wide oscillation of the biomass indices for *P. montagui* in the EAZ continues in 2015 (Fig. 7). The fishable biomass index was significantly lower when compared to 2014 at 6,137 t and the female SSB index was 3,877 t (Table 3, Fig. 7). Both are at about the same level as seen in 2011, before large inter-annual fluctuations where observed in the time series.

Exploitation

The reported ER index for 2015/16 was very low, 0.4%, because very little catch was recorded as of the 18 November Canadian Atlantic Quota Report (CAQR) (Fig. 8). The potential ER index, based on the TAC, would be 13.7%.

Current Outlook

The female SSB index in the EAZ has entered the Cautious Zone again in 2015 (Fig. 9). There is less than a 1% chance the female SSB index is above the USR while there is about a 4% chance that it is in the Critical Zone. Given the wide fluctuations in biomass indices for *P. montagui*, the status of this resource must be considered uncertain. Therefore caution is warranted when dealing with future harvest of the resource.

Western Assessment Zone – *P. borealis*

While all survey years are presented, only the last two years of data can be considered in the WAZ assessment because of the change in the surveys, resulting in a re-start of the time series.

Fishery

Catch records as of 18 November 2015 show that about 295 t or 14% of the TAC had been caught (Table 1, Fig. 10). Vessels were still fishing in the WAZ so the final catch for the season will be higher. However, it is unlikely that the TAC will be taken by the end of the season.

Biomass

The fishable biomass and female SSB indices from 2014 to 2015 are not significantly different (Table 4, Fig. 11). The fishable biomass index in 2015 was 28,532 t, while the female SSB index was about 14,710 t up from 21,712 t and 12,308 t, respectively, in the previous year.

Exploitation

Exploitation of *P. borealis* in the WAZ has been low, less than 4% of the observed fishable biomass (Fig.12a) as of the 18 November 2015 CAQR. The increase in fishable biomass along with the unchanged TAC resulted in a drop in the potential ER index from 9.6% in 2014/15 to 7.3% in 2015/16.

Current Outlook

There is no PA framework for this resource because there is no accepted biomass index for the stock at this time. Additional years of survey results will be required before new reference points can be established. However, there are no immediate concerns for this stock given the low potential ER.

Western Assessment Zone – *P. montagui*

While all survey years are presented, only the last two years of data can be considered in the WAZ assessment because of the change in the surveys, resulting in a re-start of the time series.

Fishery

P. montagui catch was 3,898 t or about 64% of the TAC through 18 November 2015 (Table 1, Fig.13). The total catch for 2015/16 will be larger since vessels were still fishing the area at that time. It is likely that most of the TAC will be taken in 2015/16.

Biomass

The fishable biomass index was 77,078 t in 2014 and 55,194 t in 2015 (Table 5, Fig. 14a). Female SSB index was 38,875 t and 27,324 t over the same time period. However, 2014 and 2015 indices are not significantly different.

Exploitation

With fishing on-going, the reported ER index is low at 7% so far in 2015/16 (Fig. 15a). The TAC increase for 2015/16 combined with a lower fishable biomass results in an increased potential ER of 11.1% for 2015/16 (Fig.15b). If the TAC was taken there is an 8% risk that the ER index would exceed 15%.

Current Outlook

There is no PA framework for this resource because there is no accepted biomass index for the stock at this time. Additional years of survey results will be required before new reference points can be established. Given the observed biomass and the risk associated with the ER index, it is recommended that the TAC not increase until further surveys are completed to better evaluate the status of *P. montagui* in the WAZ.

Conclusions

Eastern Assessment Zone

Pandalus borealis

- The *Pandalus borealis* resource is currently in the Healthy Zone well above the Upper Stock Reference.
- Fishable biomass and female spawning stock biomass indices showed sharp increases in 2015.
- The mean potential exploitation rate index, based on the Total Allowable Catch, for 2008/9-2015/16 is 14.3%. The 2015/16 potential ER index is 10.4%.

Pandalus montagui

- *Pandalus montagui* biomass indices have fluctuated widely over the past five years making conclusions about the resources status in the Eastern Assessment Zone uncertain.
- The *Pandalus montagui* female spawning stock biomass index has declined to about the mid-point of the Cautious Zone with a 4% risk of being in the Critical Zone.
- The potential exploitation rate index if the TAC is taken in 2015/16 is 13.7%.

Western Assessment Zone

Pandalus borealis

- At this time, there is no Precautionary Approach Framework for *Pandalus borealis* in the Western Assessment Zone.
- There are no immediate concerns for this stock given the low potential ER.
- The exploitation rate index for 2013/14 is about 4%. The current Total Allowable Catch equates to a potential exploitation rate of about 7%.

Pandalus montagui

- At this time, there is no Precautionary Approach Framework for *Pandalus montagui* in the Western assessment Zone.
- The *Pandalus montagui* resource status is uncertain because the new time series contains only two data points.
- The potential exploitation rate index for 2015/16 is about 11% with an 8% risk that it exceeds 15%.

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Appendix 1. Tables

Table 1. Nominal reported catches for the Eastern Assessment Zone and Western Assessment Zone for Pandalus borealis *and* P. montagui.

Year	Eastern Assessment Zone		Western Assessment Zone	
	P. Borealis	*P. montagui*	*P. borealis*	*P. montagui*
2015*	4468.15	24.70	295.22	3847.62
2014	4972.11	401.16	846.72	5835.69
2013	6793.47	1075.29	973.28	4775.29
2012	5555	1172.72	13.00	1105.41
2011	7687.10	134.81	0	857.32
2010	6908.168	483.34	56.88	345.04
2009	5158.56	563.61	0	0
2008	5184.27	807.57	0	0
2007	6358.59	1832.29	0	0
2006	6027.55	924.73	0	0
2005	6386.84	1426.71		0
2004	5841.75	2301.35		0
2003	5617.44	1217.11		0
2002	5695.33	3080.80		0
2001	6275.38	3866.87		0
2000	5718.48	4238.49		0
1999	5465.10	3780.39		0
1998	5372.24	3359.89		0
1997	5869.76	3049.94		0
1996	3345.57	3058.24		0
1995	2488.59	3192.23		0
1994	455.81	154.05		0
1993	68.24	0		0
1992	1210.10	0.74		0
1991	1150.25	622.54		0.2
1990	1633.76	174.35		4.67
1989	3132.73	1264.81		9.55
1988	2873.42	602.91		13.00
1987	0.01	0.12		0
1986	49.58	483.17		0
1985	0.08	0		0
1984	0	0		0
1983	21.135	0		0
1982	46.49	0		0
1981	0.891	9.111		2
1980	486.83	102.812		2.86
1979	0.625	58.347		25.38

** Catch based on Canadian Atlantic Quota Report as of 18 November 2015. Since the fishery is still open the catch is not complete for 2015.*

Table 2. Fishable and female spawning stock biomass estimates for Pandalus borealis *in the Eastern Assessment Zone for the 2006-2015 surveys. LCL and UCL are the lower and upper 95% confidence limits.*

		Weight (tonnes)		
Year	Biomass	Mean	LCL	UCL
2015	Fishable	78984.09	50852	106962
2014	Fishable	50457.99	38914	62340
2013	Fishable	49636.90	38427	60631
2012	Fishable	60533.67	43074	79960
2011	Fishable	78530.23	23900	135037
2010	Fishable	71064.51	40234	108703
2009	Fishable	78754.88	48850	110115
2008	Fishable	51053.43	37117	66708
2007	Fishable	43305.97	31015	58346
2006	Fishable	32815.89	21969	44152
2015	Female SS	60869.47	33379	88386
2014	Female SS	34069.42	25157	43000
2013	Female SS	32049.10	26762	37607
2012	Female SS	41189.85	29498	54383
2011	Female SS	47806.80	13470	82926
2010	Female SS	43800.31	19025	79665
2009	Female SS	38856.32	23122	56820
2008	Female SS	27653.12	22507	39368
2007	Female SS	27698.44	19249	39007
2006	Female SS	16805.06	10523	23026

Table 3. Fishable and female spawning stock biomass estimates for Pandalus montagui *in the Eastern Assessment Zone for the 2006-2015 surveys. LCL and UCL are the lower and upper 95% confidence limits.*

		Weight (tonnes)		
Year	Biomass	Mean	LCL	UCL
2015	Fishable	6136.90	3445	8629
2014	Fishable	16599.97	11203	22084
2013	Fishable	3534.28	1738	6208
2012	Fishable	28845.47	8582	48946
2011	Fishable	7739.99	2871	14285
2010	Fishable	7422.75	5714	9290
2009	Fishable	15679.12	6190	29774
2008	Fishable	14667.04	7287	21973
2007	Fishable	4828.25	3389	6673
2006	Fishable	2667.14	210	5122
2015	Female SS	3876.62	2085	5452
2014	Female SS	12696.30	8834	16622
2013	Female SS	2777.54	1301	4949
2012	Female SS	23552.02	6218	40985
2011	Female SS	3124.24	1599	4721
2010	Female SS	5819.10	4509	7136
2009	Female SS	8775.54	4205	13955
2008	Female SS	10659.82	4269	17047
2007	Female SS	1970.63	903	3490
2006	Female SS	2134.38	50	4219

Table 4. Fishable and female spawning stock biomass estimates for Pandalus borealis *in the Western Assessment Zone. Note 2014 and 2015 represent a new time series and values are not directly comparable to previous years. LCL and UCL are the lower and upper 95% confidence limits.*

		Weight (tonnes)		
Year	Biomass	Mean	LCL	UCL
2015	Fishable	28532.16	18531	39501
2014	Fishable	21712.50	14353	31046
2013	Fishable	21998.56	15906	28519
2011	Fishable	19692.10	12468	27961
2009	Fishable	15543.95	10603	21650
2007	Fishable	14615.00	8192	22356
2015	Female SS	14710.39	9270	20379
2014	Female SS	12308.93	8792	16398
2013	Female SS	9785.03	7106	12829
2011	Female SS	6376.60	4182	8909
2009	Female SS	3839.38	2184	4344
2007	Female SS	3231.00	2281	4344

Table 5. Fishable and female spawning stock biomass estimates for Pandalus montagui *in the Western Assessment Zone. Note 2014 and 2015 represent a new time series and values are not directly comparable to previous years. LCL and UCL are the lower and upper 95% confidence limits.*

		Weight (tonnes)		
Year	Biomass	Mean	LCL	UCL
2015	Fishable	55194.40	35769	76429
2014	Fishable	77077.74	44854	111562
2013	Fishable	45647.22	32899	59438
2011	Fishable	71557.90	40264	108612
2009	Fishable	46672.87	35026	73342
2007	Fishable	54044.50	25723	84280
2015	Female SS	27323.60	18282	37041
2014	Female SS	38875.39	23553	55849
2013	Female SS	26955.19	18016	35736
2011	Female SS	32549.40	20296	46119
2009	Female SS	17998.70	13908	22322
2007	Female SS	19277.30	8902	32302

Appendix 2. Figures

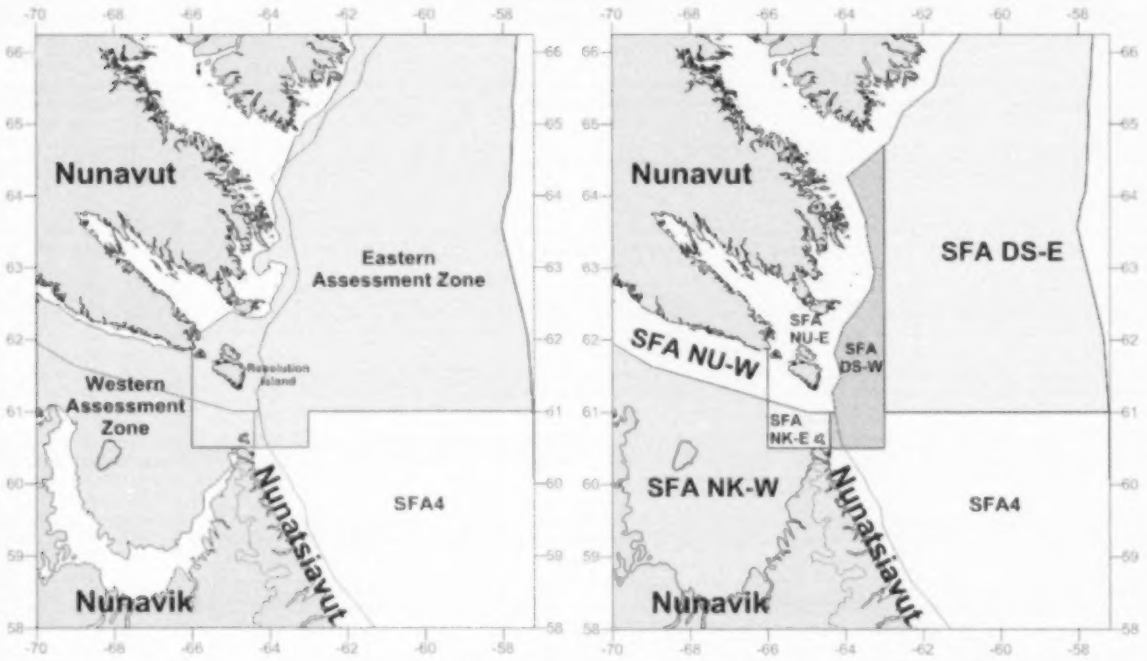

Figure 1. Location of the Western and Eastern assessment zones (left panel) and corresponding Shrimp Fishing Area (SFA) management units (right panel). Boundaries of the Nunavut (NU), Nunavik (NK) and Nunatsiavut Land Claims Areas are identified with red lines. Abbreviations for Davis Strait (DS), East (E) and West (W) are used.

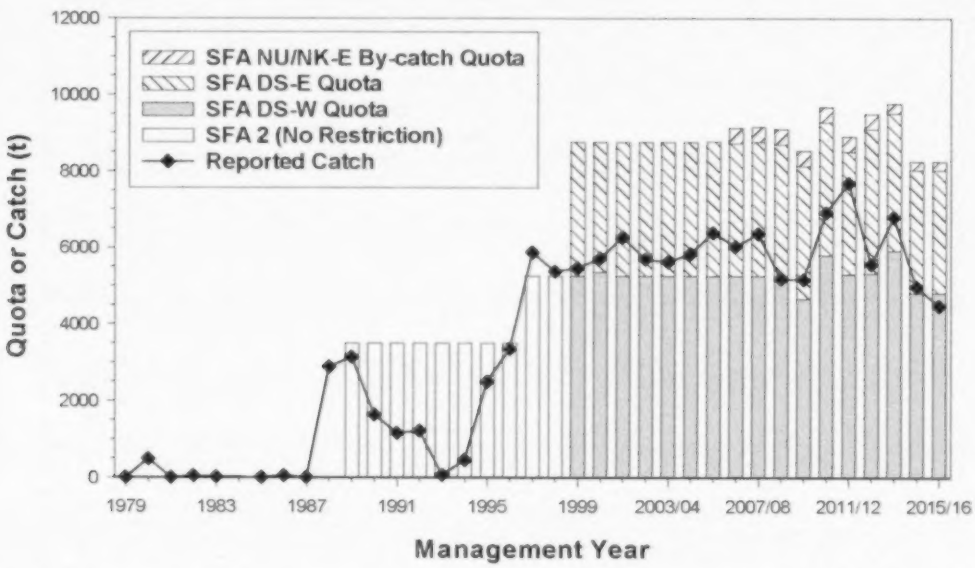

Figure 2. Eastern Assessment Zone Pandalus borealis *TAC and catch recorded in the Canadian Atlantic Quota Report (CAQR). Catch based on CAQR as of 18 November 2015; since fishery is still open the catch is not complete for 2015. Quota for 1999-2012/13 renamed to correspond to new management areas.*

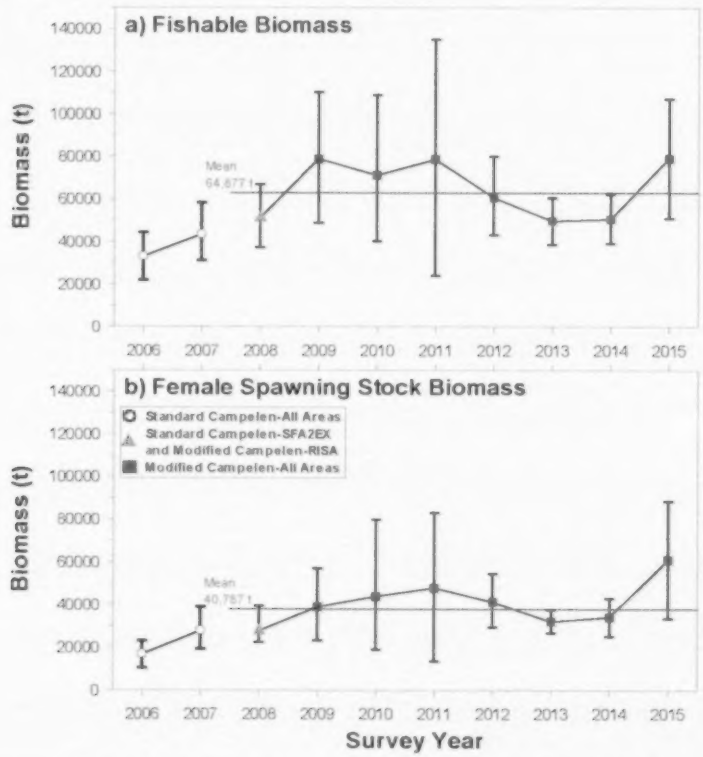

Figure 3. Eastern Assessment Zone Pandalus borealis *a) fishable and b) female spawning stock biomass indices for the survey years 2006-2015. Error bars are 95% confidence ranges.*

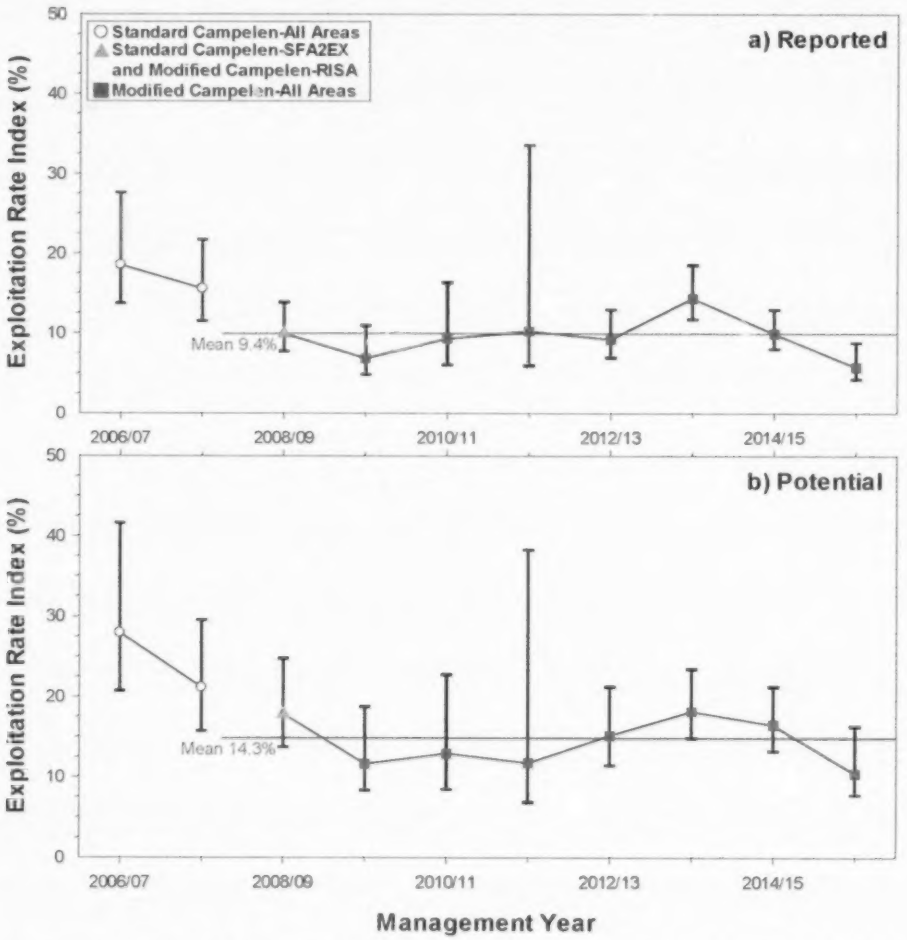

Figure 4. Eastern Assessment Zone Pandalus borealis *a) reported and b) potential exploitation rate indices for 2006/07-2015/16. Error bars are 95% confidence ranges.*

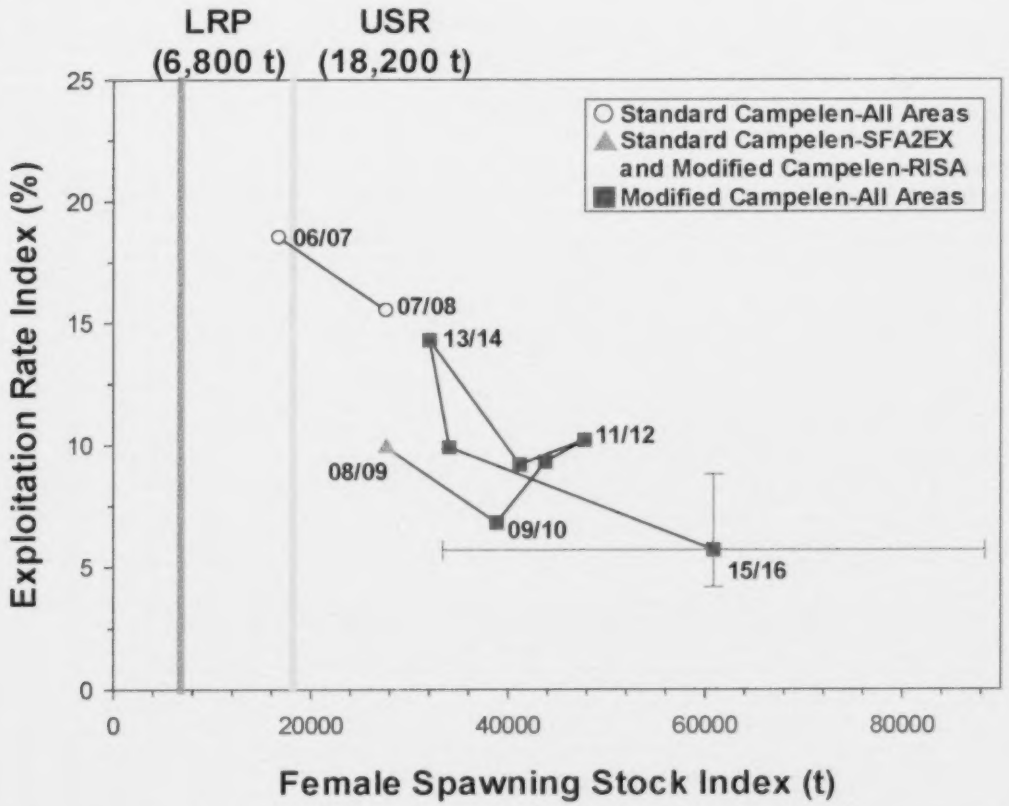

Figure 5. Eastern Assessment Zone trajectory of Pandalus borealis *female spawning stock biomass and exploitation rate indices in relation to reference points. For 2015/16, SSB is known but the exploitation rate estimate is preliminary since it is based on incomplete catch for the management year. USR=Upper Stock Reference and LRP=Limit Reference Point. Error bars are 95% confidence ranges*

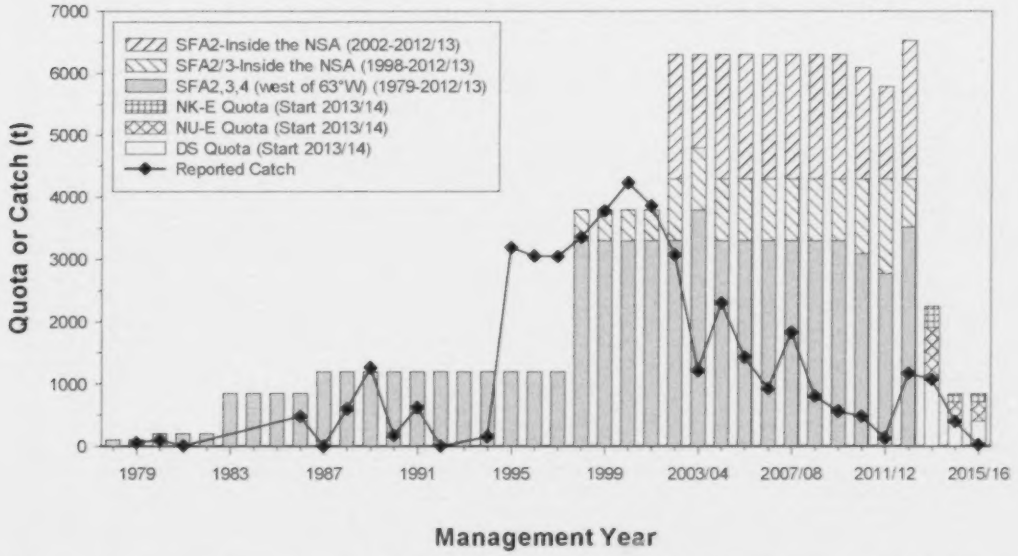

Figure 6. Eastern Assessment Zone Pandalus montagui *TAC and catch recorded in the Canadian Atlantic Quota Report (CAQR). Catch based on CAQR as of 18 November 2015; since fishery is still open the catch is not complete for 2015. New management units were implemented for the 2013/14 season.*

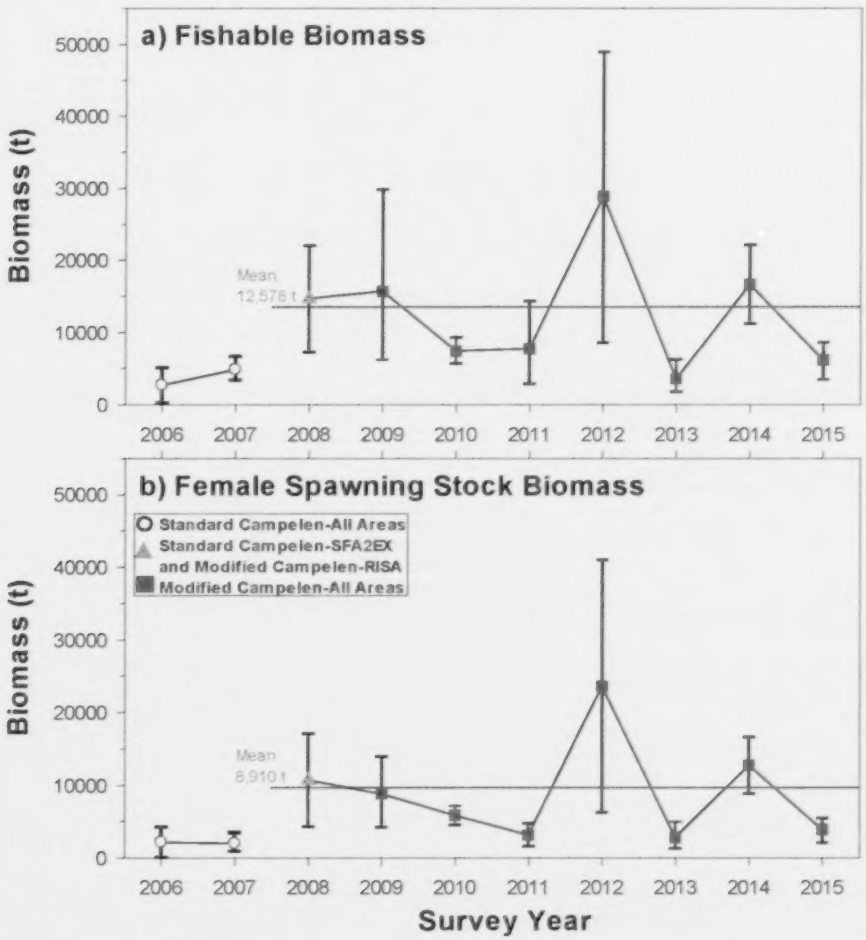

Figure 7. Eastern Assessment Zone Pandalus montagui *a) fishable and b) female spawning stock biomass indices for the survey years 2006-2015. Error bars are 95% confidence ranges.*

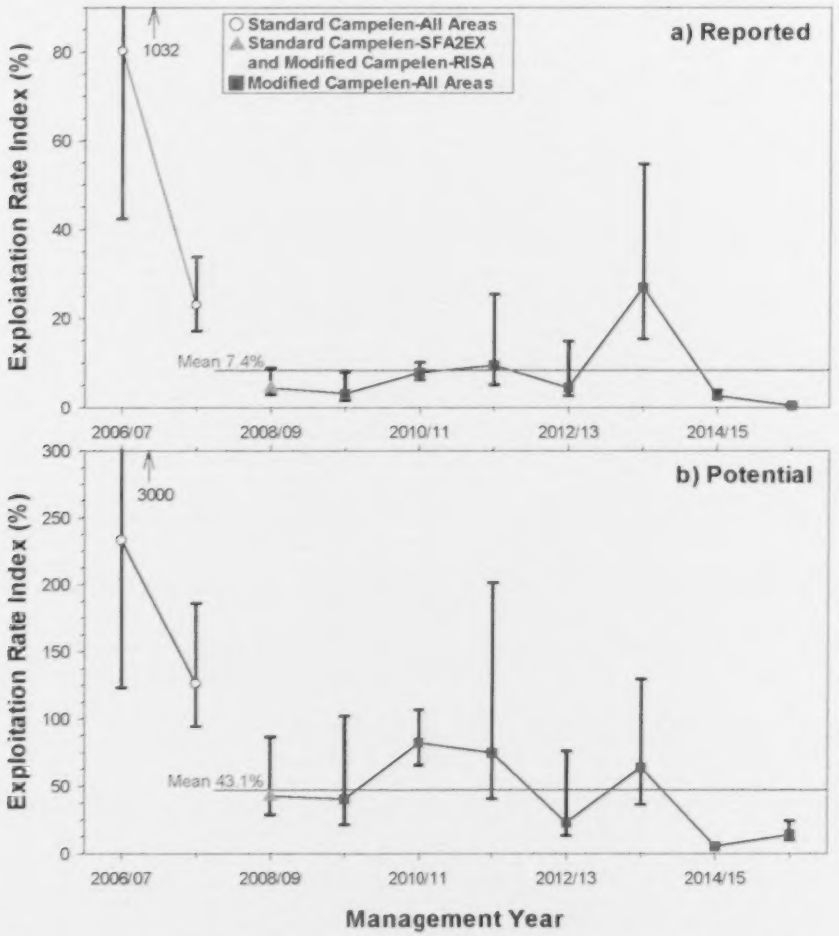

Figure 8. Eastern Assessment Zone Pandalus montagui *a) reported and b) potential exploitation rate indices for 2006/07-2015/16. Error bars are 95% confidence ranges.*

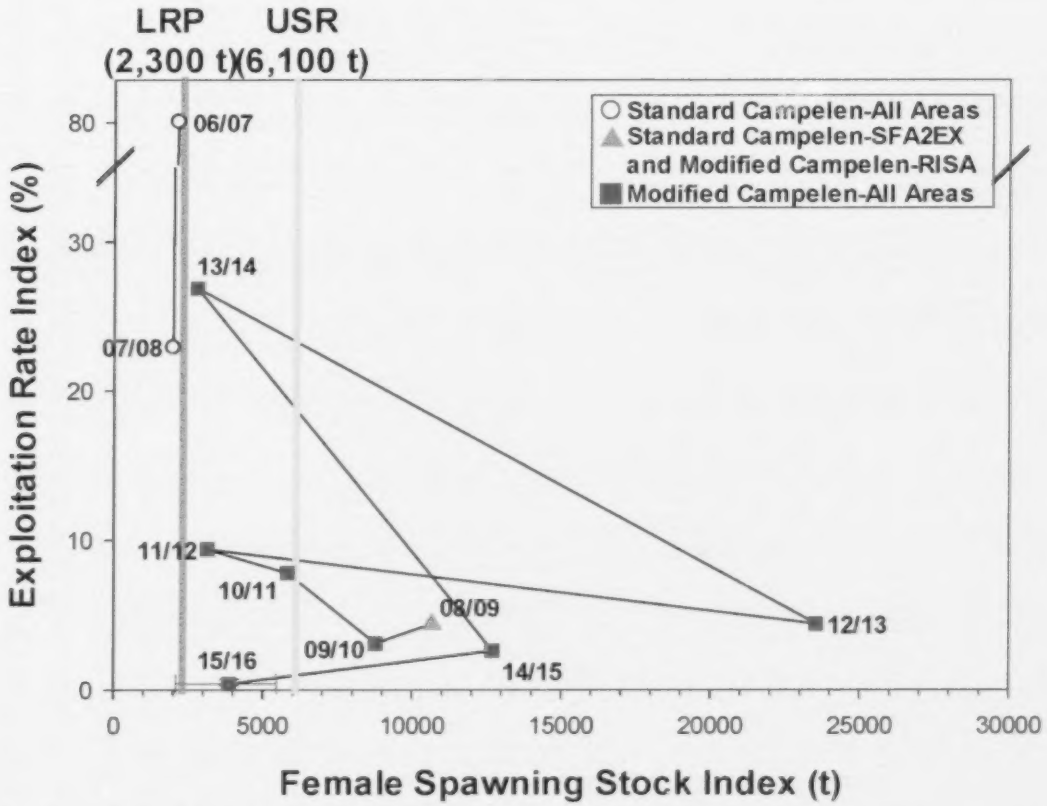

Figure 9. Eastern Assessment Zone trajectory of Pandalus montagui *female spawning stock biomass and exploitation rate indices in relation to reference points. For 2015/16, SSB is known but the exploitation rate estimate is preliminary since it is based on incomplete catch for the management year. USR=Upper Stock Reference and LRP=Limit Reference Point.*

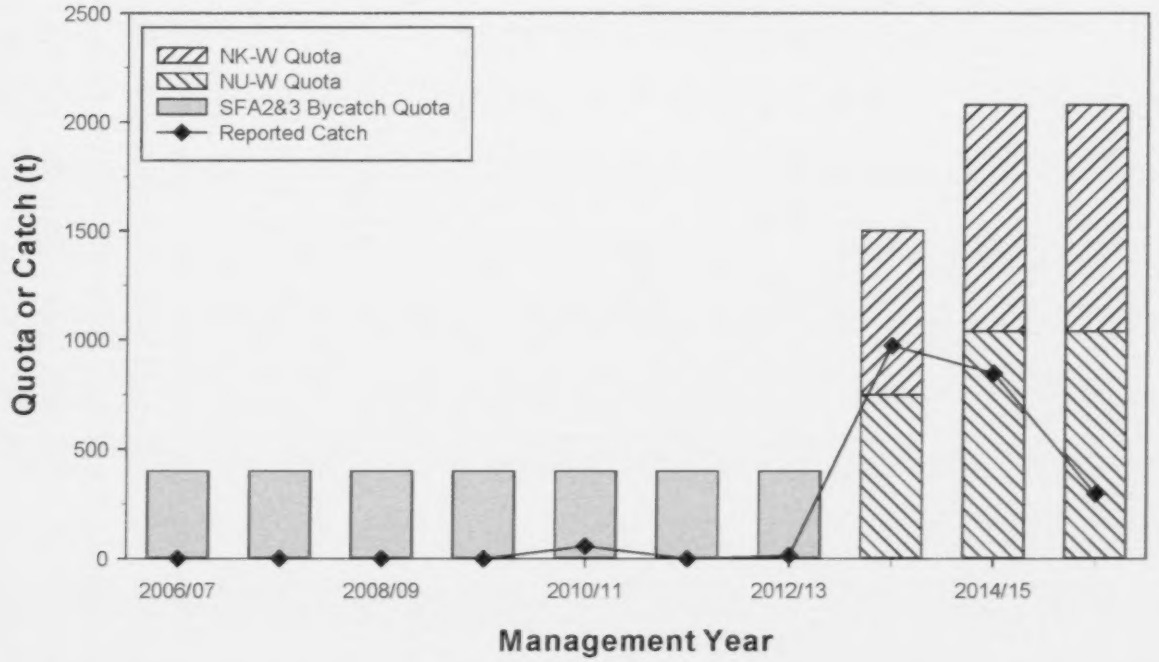

Figure 10. Western Assessment Zone Pandalus borealis *TAC and catch recorded in the Canadian Atlantic Quota Report (CAQR). Catch based on CAQR as of 18 November 2015; since the fishery is still open the catch is not complete for 2015. New management units were implemented for the 2013/14 season.*

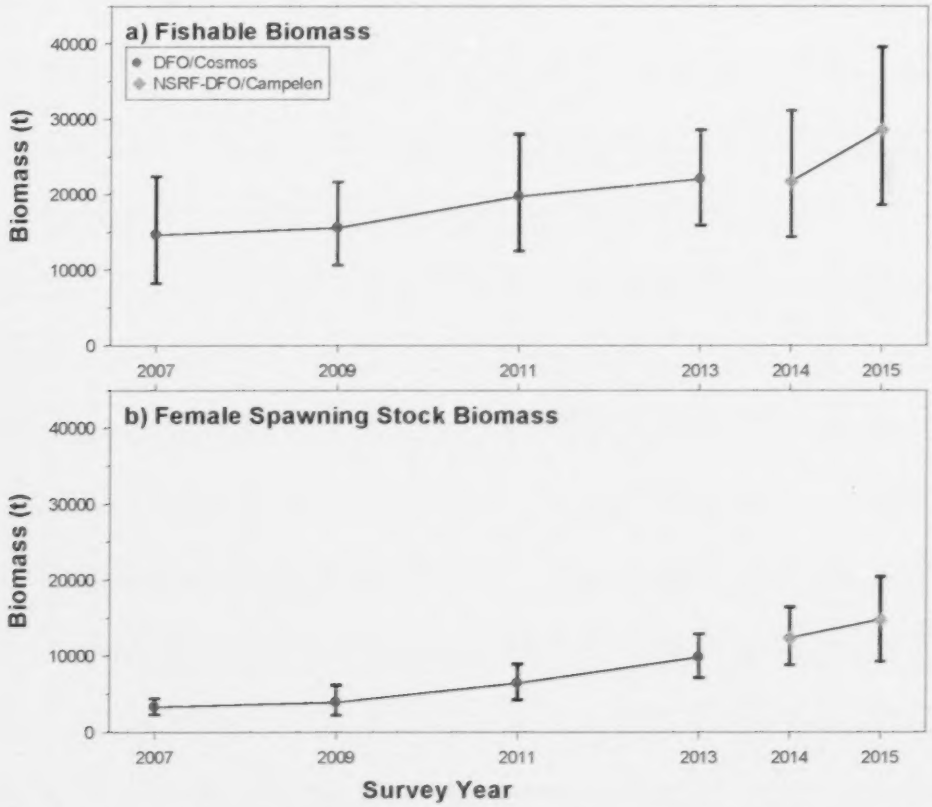

Figure 11. Western Assessment Zone Pandalus borealis, *a) fishable biomass and b) female spawning stock biomass indices for the four years of DFO/Cosmos surveys and two years conducted by the NSRF-DFO/Campelen. Biomass indices from the two surveys are not directly comparable. 2014 represents the start of a new time series for the WAZ. Error bars are 95% confidence ranges.*

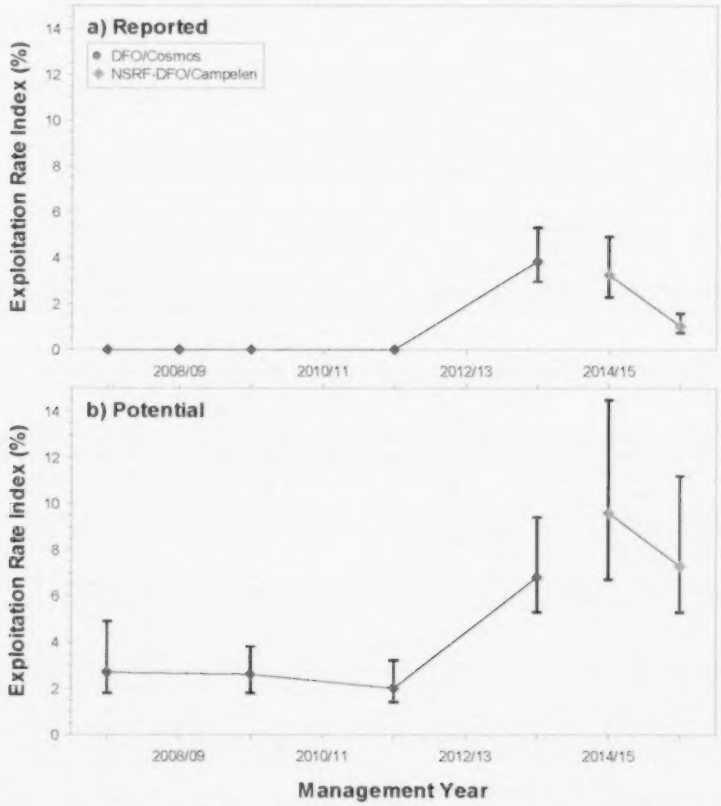

Figure 12. Western Assessment Zone Pandalus borealis *a) reported and b) potential exploitation rate indices for the four years of DFO/Cosmos surveys and two years conducted by the NSRF-DFO/Campelen. Exploitation rate indices from the two surveys are not directly comparable. 2014 represents the start of a new time series for the WAZ. Error bars are 95% confidence ranges.*

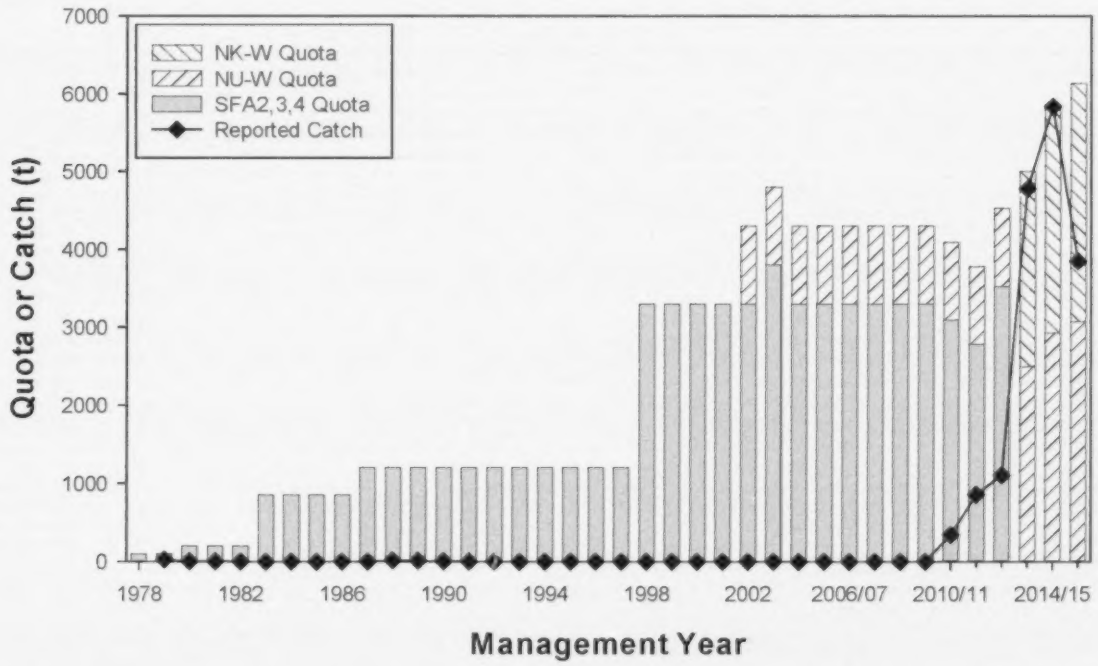

Figure 13. Western Assessment Zone Pandalus montagui *TAC and catch recorded in the Canadian Atlantic Quota Report (CAQR). Catch based on CAQR as of 18 November 2015; since fishery is still open the catch is not complete for 2015. New management units implemented for the 2013/14 season.*

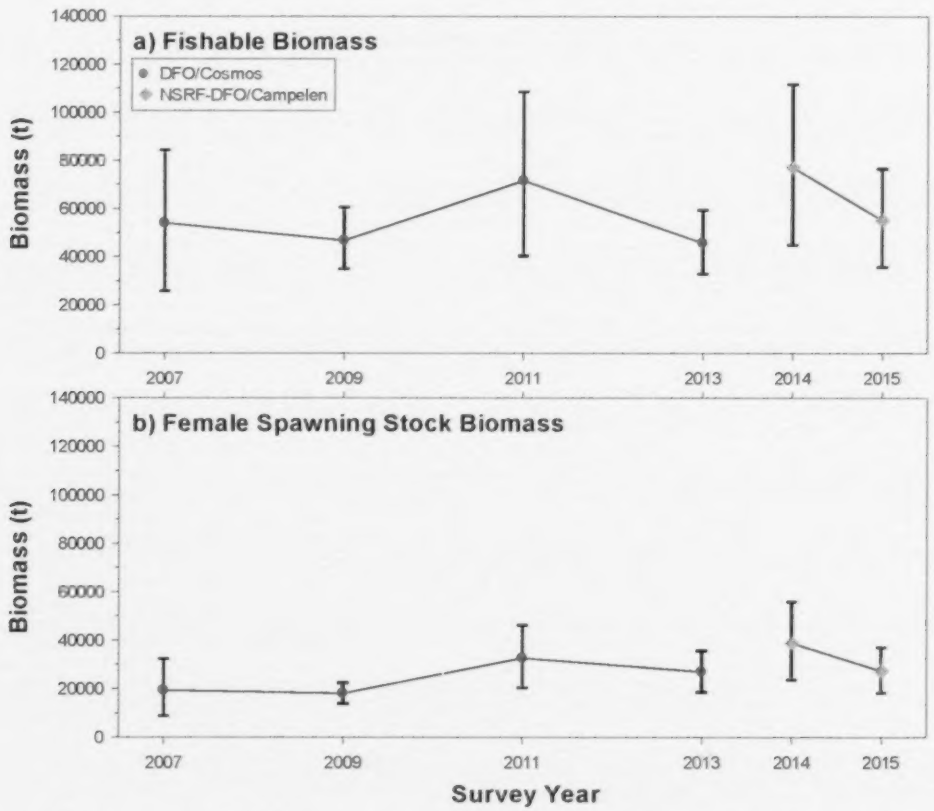

Figure 14. Western Assessment Zone Pandalus montagui, *a) fishable biomass and b) female spawning stock biomass indices for the four years of DFO/Cosmos surveys and two years conducted by the NSRF-DFO/Campelen. Biomass indices from the two surveys are not directly comparable. 2014 represents the start of a new time series for the WAZ. Error bars are 95% confidence ranges.*

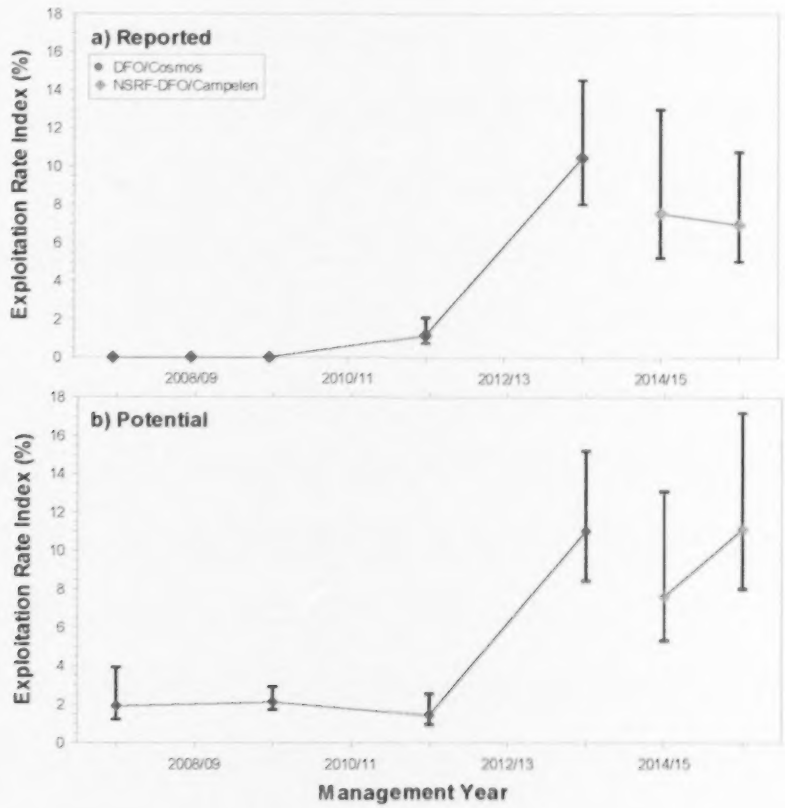

Figure 15. Western Assessment Zone Pandalus montagui *a) reported and b) potential exploitation rate indices for the four years of DFO/Cosmos surveys and two years conducted by the NSRF-DFO/Campelen. Exploitation rate indices from the two surveys are not directly comparable. 2014 represents the start of a new time series for the WAZ. Error bars are 95% confidence ranges.*

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